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ABSTRACT

The interactive monitoring of group communication through computers is a procedure analogous to biofeedback, and small group communication computer programs have been developed with monitoring software that has been used to evaluate the impact of the medium on group communication. There is presently no technical reason that such information could not be made available to users of computer conferencing. An interactive monitor would allow the group to spot possible communication barriers and then determine proper interventions to reduce the barriers, thus providing an evaluation and alteration mechanism. A 4-part system known as HUB is being developed that includes a computer conferencing facility, a graphic communication facility, a program workspace, and a document workspace. It monitors variables in several categories: group processes: individual communication styles: and task performance. Data display, a complex and challenging task, is currently under development. The system is expected to (1) develop roles for a group facilitator: (2) encourage experimentation with group structures: and (3) provide evaluation of group and individual performance. Current planning calls for field tests of HUB and its monitoring subsystem over the next two years. (PAA)

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INTERACTIVE MONITORING
OF COMPUTER-BASED GROUP COMMUNICATION

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INTRODUCTION

Biofeedback is a procedure for monitoring unconscious or involuntary bodily processes and making them perceptible to the senses. The objective is to increase consciousness and therefore control of the bodily processes as a means of improving health.

This paper is not about health or biofeedback, but it does describe a procedure that is perhaps analogous to biofeedback: the interactive monitoring of group communication through computers.

Over the last decade, a number of computer programs have been developed to support small-group communication: these include PLANET, EIES, PARTYLINE & DISCUSSION, CMI, CONFER, MINT, and RIMS.* Since these programs act as a kind of gatekeeper for the communication process--directing participants to appropriate "activities" and ordering their "messages"--they can easily be extended to record important features of the group's communication patterns. For example, during its development phase, the PLANET system included monitor software that collected and analyzed information about the time users entered and left a PLANET activity, the number

* PLANET was developed by the Institute for the Future; EIES by Murray Turoff at the New Jersey Institute of Technology; PARTYLINE & DISCUSSION by Rod Renner and Murray Turoff; CMI by Bell Canada; CONFER by University of Michigan; MINT by the Nonmedical Use of Drugs Directorate in Canada; and RIMS by Murray Turoff for the Federal Office of Preparedness. For a description of these systems, see Robert Johansen, Jacques Vallee, and Kathleen Spangler, *The Camelia Report*, Institute for the Future, Report R-37, 1977.

of public and private messages sent, the number of words in public and private messages, the use of commands, the typing time, and the number of computer resource units used, among other statistics. This information was used to evaluate the impact of the medium on group communication, and it revealed several different styles of computer conferencing among users of the system.*

The information from the PLANET monitor software was not available to those who were participants in PLANET conferences during their discussions. However, there is no technical reason why such information could not be made available to users of computer conferencing. It could then serve as a kind of biofeedback about the group communication process, increasing the group's consciousness of its communication patterns and thereby giving them more control over those patterns.

An interactive monitor would allow the group to spot possible communication barriers: nonparticipants, isolated subgroups, and poor access to important resources, for example. The group leader or the group as a whole could then determine whether some intervention would reduce these barriers. An interactive monitor could also provide insights into the efficiency of the group communication process; it could display to the group its volume of communication, the timeliness of information exchange, and the cost of communication. Over a long period of time, such a monitor could chart the history of the group, displaying informal changes in the group's organization that may suggest the need for formal changes. In short, an inter-

* See Jacques Vallee et al., *Group Communication Through Computers*, Volumes 3 and 4, Institute for the Future, 1975 and 1977; and Robert Johansen et al., *Group Communication Through Computers*, Volume 5, Institute for the Future, 1977.

active monitor could be used to evaluate and alter the group's communication process.

IMPLEMENTING THE MONITOR: THE HUB SYSTEM

At the Institute for the Future, we have begun to implement this concept for groups with a specific communication purpose--the construction of large-scale policy models. We have designed a communication system known as HUB. The HUB system, which resides on the Bolt, Beranek and Newman PDP-10 computer in Boston, is a four-part communication system. The four parts include:

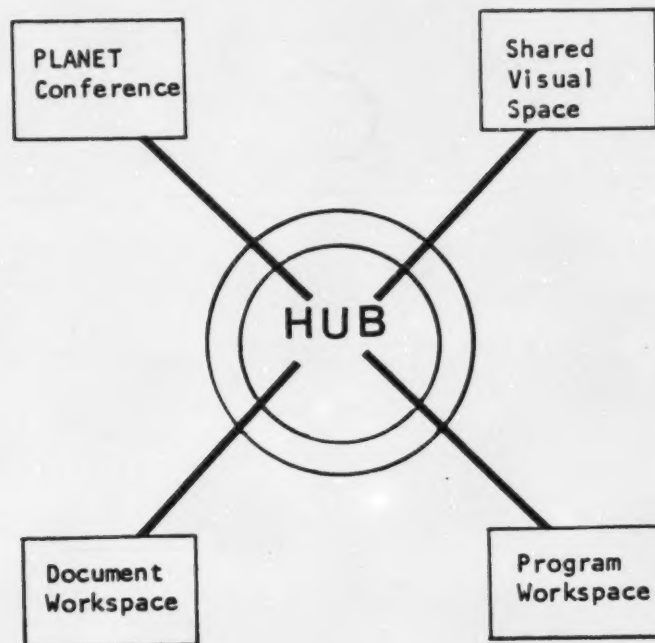
- a computer conferencing facility that uses the PLANET program,
- a graphic communication facility (the "shared visual space") that allows users to create graphic images from picture primitives and to comment on these images,
- a "program workspace" that allows users to run a variety of computer programs and to discuss them while they are being seen or to comment on them later, and
- a "document workspace" that allows a group of users to develop a document jointly by making changes on a single version and annotating those changes in comments.

A HUB "switcher" makes it easy for users to access and move among each of these four systems, as illustrated in Figure 1. It is in this switcher that the HUB monitor is located, and it is here that users interact with it.

IMPLEMENTING THE MONITOR: WHAT TO MONITOR

In designing the monitor, of course, one of the central questions is: what should be monitored? To answer this question, we began by considering the complex set of variables that combine to shape group communication.

FIGURE 1
THE HUB SYSTEM



One useful way of grouping these variables is according to three categories: (1) group process, (2) individual communication styles, and (3) task performance.* These categories suggest an outline for identifying the kinds of information that may be useful to a team of modelers in the course of a HUB conference.

Consider first the *group process* variables. One of the most important issues for groups of all kinds is participation. The level of participation of various group members reflects leadership patterns, productivity of the group, and the availability of resources to the group. It can also

* For a review of taxonomies of group communication through electronic media, see Robert Johansen, Richard Miller, and Jacques Vallee, "Group Communication through Electronic Media," *Educational Technology*, August 1974, pp. 7-20.

reveal subgroups who may have certain unique communication needs, but also unique problems in communicating with the larger group. In a HUB conference, we imagine that the following information about participation would be useful:*

- volume of communication per day, week, or month for the entire group (in both comments and words), for the entire system, and for each part of the system (i.e., PLANET, program workspace, etc.);
- length of comments in each part;
- distribution of participation over time;
- distribution of participation within each part and across parts of the HUB system;
- dominant participants for each part; for the system as a whole;
- percent synchronous participation for each part; and
- cost of communication per unit time.

Each individual in the group will have his or her own characteristic style of communication. The monitor should be able to provide a profile of this style. Many of the variables in such a profile are similar to those for the group as a whole. For example, the profile should probably include:

- the volume of communication generated by the individual compared to the volume of the group as a whole;
- the individual's frequency of communication;
- the changing position of the individual in the distribution of participation over time and across parts;
- his/her use of programs compared to others in the group (number of runs initiated in the program workspace);

* Obviously, this list is not exhaustive; it does, however, include the major patterns that can be collected or calculated automatically.

- percent time spent in synchronous interaction;
- his/her private communication network (in PLANET);
- the "accessibility" of an individual to others in the group;* and
- his/her cost to use the system per unit time, compared to the total group.

The task performance variables are perhaps most specifically related to the unique communication problems of modeling groups. These problems include a lack of communication between builders and users of models due to organizational barriers, perceptual barriers, and different levels of skill in working with computers and mathematical concepts; a tendency for individual members of the modeling team to "do their own thing" rather than to work in a collaborative style; problems of documentation; and problems of confidence in the model due to difficulties in interpreting results, in understanding the model structure, and in recognizing factors that are not considered in the model, all of which lead to questions about the validity of the model.**

Much of the information that would be useful in diagnosing and correcting these problems cannot be easily collected by an automatic monitor.*** However, since the various parts of the HUB system are really

* "Accessibility" in a HUB conference can be measured by the time lag between the sending of a message and its receipt by any particular individuals. The longer the average time lag, the lower the accessibility.

** For a full discussion of communication problems in the modeling process, see Hubert Lipinski, Roy Amara, and Kathleen Spangler, "Communication Needs in Computer Modeling," *Proceedings of the Winter Simulation Conference*, Miami, Florida, December 1978.

*** For example, an indicator of difficulties arising due to perceptual or disciplinary barriers is the use of specialized jargon by subgroups. A content analysis of the transcript would reveal such a pattern; however it is not done easily by an automatic monitor.

designed to facilitate different tasks, the usage patterns for each of these parts provide a task-related profile of the group's communication. For example, the volume of activity in each part is likely to change as the focus of the project shifts from one task to another. These shifts can be monitored over time; individual participation patterns can be overlaid on these volume patterns. Such information would demonstrate who is involved in what types of activity at any point in time.

It will also be useful to collect specific data for each of the subparts to clarify issues of task performance. For example, it will be useful to know:

For the shared visual space,

- the number of versions of each graphic image;
- the ratio of comments to graphic commands;
- the length of time to produce a completed graphic image;
- the frequency of use of graphic commands; and
- the cost to produce a completed graphic image.

For the program workspace,

- the number of runs for each program;
- the number of comments per run;
- the number of synchronous runs;
- the number of times each run is reviewed;
- the number of unique input files;
- the ratio of program lines to comment lines; and
- the cost of each run.

For the document workspace,

- the number of text changes over time;
- the ratio of text changes to comments;
- the number of times a document is printed in full;
- the average line length of text changes;
- the number of synchronous text changes;
- the number of reviews of text changes; and
- the cost per text change (including and excluding comments).

In addition to this information, the group can evaluate its overall task performance by considering some of the data about the "time effectiveness" of information exchange in various parts of HUB. Thus, the HUB monitor should collect statistics on the length of time between any program run and its review by any other participant; between any graphic change and its review by any other participant; between any document change and its review by any other participant; and between comments in any of the four parts and their review by any other participant. Such measures will provide a very dynamic view of the communication process.

Many of the communication variables in these four categories are related; in fact, all of them can be calculated from a relatively small number of statistics, which the HUB monitor is designed to collect. In addition to these statistics that are collected unobtrusively, the monitor files include space for two other types of information: (1) hand-coded information about the message and (2) responses to structured questions. Thus, it would be possible, for example, for someone to content-analyze a series of messages (e.g., for the use of jargon) and hand-code this

information into the monitor to be displayed with network patterns for the messages. The second feature--responses to structured questions--would allow the conference organizer to poll the users' feelings about the group process, which would then also be available to supplement the statistics on communication patterns.

IMPLEMENTING THE MONITOR: HOW TO DISPLAY

The procedures for collecting monitor statistics are quite simple. The procedures for displaying them to the group are more complex. First, there are choices about how to represent information about all of the communication variables noted above. Some of these can be shown as simple ratios, but most of them call for some form of graphic display. Some of these, such as network graphs that must be constructed to show the strength of links, can be quite complex. Second are choices about how the users interact with the monitor: Do they automatically get a display of 20 or 30 preset graphs and figures or do they specify what they want to see? And if they specify what they want to see, how do they know what they can display? Closely related is a third question about how much control users have over what can be displayed. On one hand, there may be only one fixed representation for each major variable. On the other, the users might be able to manipulate the representation to emphasize certain aspects of it, or they might even be able to combine two or three variables to suggest correlations. Finally, there may be certain variables that are pre-selected as significant; in this case the monitor could automatically notify the group when this variable reached some critical level.

Because we are still in the process of developing the HUB monitor, we have not made all of these choices. However, it seems clear that the way in which the variables are displayed could make a significant difference in the impact of the monitor data on the group. Furthermore, it seems clear that there are a number of creative ways to display the information that might speak directly to problems that plague modelers. For example, labeling people by some label other than their names could provide some interesting insights. If a graph showing distribution of participation were labeled by disciplines rather than names, it might become clear, for example, that subgroups are developing along disciplinary lines. The group could then assess whether this pattern is appropriate for the phase of the activity or whether some important insights are being lost due to lack of effective communication between the subgroups. It thus seems that a primary criterion for decisions about how to display the monitor data should be flexibility to design displays that do, in fact, address particular problems that the group may have.

AFTER IMPLEMENTATION: THE IMPACT ON COMMUNICATION

We have suggested that an interactive monitor could have an effect on the group communication process that is comparable to that of biofeedback--namely, that it can increase consciousness and therefore control of the group's communication patterns. But we can now speculate about some more specific impacts--both negative and positive--of the type of monitor that we are implementing for the HUB system.

One possible effect is that there will develop a new role in the communication process for a group facilitator. We have already noted the tendency for such a role to develop in PLANET conferencing.* In a HUB activity, this role might include responsibility for checking the monitor regularly and interpreting the results for the group. The facilitator might use the private message mode to counsel individual group members about their participation patterns or might use the displays in group sessions to consider the implications of the patterns for complaints or difficulties that the group may be experiencing.

A second likely effect of the monitor would be to encourage more experimentation with group structures. As the group becomes more conscious of its communication patterns, it may wish to intervene in these patterns by tinkering with roles and responsibilities and then following the monitor to observe the effects of the experimentation.

It seems very likely that such a monitor could and would be used to evaluate the group's performances and the performances of individual members. Certainly, it would make an individual's contribution to the group more apparent; it would also provide a reading on the more elusive measures of performances, such as ability to get along with one's colleagues. Such an evaluation tool may indeed seem attractive to someone who is faced with objectively evaluating a group of people; however, there are also real dangers here. First, there is the possibility that the very existence of the monitor will inhibit some communication, and it may actually discourage

* See Jacques Vallee et al., *Group Communication Through Computers*, Volume 4, Institute for the Future, 1977.

the participation of some people altogether. Also, the monitor may encourage some people to "perform" for the monitor, to alter their behavior just to show up well in the monitor data. Finally, the use of the monitor could encourage evaluation of the *wrong* aspects of performance, particularly if the data that are easily collected are not the best data for evaluation.

The way that the HUB monitor will be used by groups and the effects on modeling communication remain to be assessed. Our plans call for field tests of HUB over the next two years. The role of the monitor will be an important focus of this evaluation.